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with which the product can be put into production. After the production level is increased and the requirements for better product quality are imposed, it may be desirable to change to pressure molded products when the higher production level justifies the increased tooling costs. However there are high production casting lines, such as encasing jewelry, emblems, etc., that are more beneficial costwise.

In many cases design modifications can substantially improve the productibility of the products and reduce their cost with improved product quality. As an example if voids exist the problem can usually be corrected by modifying or changing the plastic's composition and/or the use of a vacuum system during the casting. Understanding the effects of the process on the product is essential in making successful products.

Specific information in this area is usually available from the processor who has experience with a wide variety of products and knows the type of problems that have been encountered in the past.

Because of the complexities of the materials and the effects of the processing on the materials, this is an area where predictability based on scientific data is very limited and casting experience is desirable. Successful products will result from close cooperation between designer, tool designer, mold maker, and processor to arrive at design compromises that make the products acceptable and producible at an economical price.

Law and Regulation

The consuming public must assume that the producer of a product has shown reasonable consideration for the safety, correct quantity, proper labeling, and other social aspects of the product. Since the 1960s these types of important concerns have expanded and been reinforced by a recognition of the consumer's right to know as well as by concerns for conservation, ecology, antilittering, and the like. Numerous safety-related and socially responsible laws have been enacted and more are on the way.

A designer's failure to be aware of and comply with existing regulations can lead to legal entanglements, fines, restrictions, and even jail sentences. In addition, there are also the penalties of costly, damaging publicity, lawsuits, and the loss of consumer goodwill. In the meantime, as for all other industries, the goal of reliable companies and associations is to produce products that eliminate potential problems. Unfortunately, nothing is perfect, so problems can develop, which is simply a fact of life. And there is always more to be done, as in the disposal issue (like eliminating wars and having all people like each other).

There are many examples of action to eliminate or reduce problems. As an example there is the Quality System Regulation (**APPENDIX, TERMINOLOGY**). FDA requires details on how products made of different materials (steel, glass, plastic, etc.) such as medical devices be manufactured. The details of the process are documented so that once a product produced in USA is approved, the product can only be produced by following what was in the QSR preparation. No change can be made. The exact plastic composition has to be used, process control settings remain the same, etc. Literally if a waste paper basket had been identified and located in a specific location in the plant, you can not relocate, change its size, etc. It has been reported that to make a change could cost literally over a million dollars. Result of the QSR regulation is too ensure the safety of a person when the medical device is used. The QSR approach should be considered/used by plastic fabricators and/or product customers when rigid requirements exist.

On just the subject of appliance safety the Underwriters Laboratories (UL) have published more than four hundred safety standards to assess the hazards associated with manufacturing appliances. These standards represent basic design requirements for various categories of products covered by the organization. For example, under UL's Component Plastics Program a material is tested under standardized, uniform conditions to provide preliminary information as

to a material's strong and potentially weak characteristics.

The UL plastics program is divided into two phases. The first develops information on a material's long- and short-term properties. The second phase uses these data to screen out and indicate a material's strong and weak characteristics. For example, manufacturers and safety engineers can analyze the possible hazardous effects of potentially weak characteristics, using UL standard 746C.

Products manufactured using concepts in UL Standard 746D provide quick verification of material identification, along with the assurance that acceptable blending or simple compounding operations are used that would not increase the risk of fire, electrical shock, or personal injury.

The Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances (UL 94) has methods for determining whether a material will extinguish, or burn and propagate flame. The UL Standard for Polymeric Materials-Short Term Property Evaluations is a series of small-scale tests used as a basis for comparing the mechanical, electrical, thermal, and resistance-to-ignition characteristics of materials.

It is the general consensus within the worldwide "fire community" that the only proper way to evaluate the fire safety of products is to conduct full-scale tests or complete fire-risk assessments. Most of these tests were extracted from procedures developed by the American Society for Testing and Materials (ASTM) and the International Electrotechnical Commission (IEC). Because they are time tested, they are generally accepted methods to evaluate a given property. Where there were no universally accepted methods the UL developed its own.

The advisory committees for developing the test protocol include the following:

American Association of Retired Persons (AARP)

American Furniture Manufacturers Association (AFMA)

American Hotel and Motel Association (AHMA)

American Society for Testing and Materials (ASTM)

Carpet and Rug Institute (CRI)

Consumer Product Safety Commission (CPSC)

Fire Marshals Association of North America (FMANA)

Fire Retardant Chemicals Association (FRCA) General Services Administration (GSA)

International Association of Fire Chiefs (IAFC)

Man-Made Fiber Producers Association (MMFPA)

National Association of Home Builders (NAHB)

National Institute of Standards & Technology (NIST)

National Conference of States on Building Codes and Standards (NCSBCS)

National Electrical Manufacturers Association (NEMA)

Underwriters Laboratories (UL)

U.S. Fire Administration (USFA)

Designing and Legal Matter

In designing a product factors to consider include protecting your design, product liability, and many more. It is important to recognize what laws and legal matters exist or actions can occur unfortunately for even the "good guy." This type of information or action could be considered a competitive situation. It is important to keep up to date on laws and legal matters that can effect your product. The following provides some general information guides.

Accident Report

Fabricators/manufacturers do not plan for their products to fail or to cause harm to people. But if an incident should occur that results in serious injury or death, the problem must be investigated immediately to prevent

it from occurring again. U.S. Federal regulations require that a manufacturer report the event to FDA. However, the customer, the patient, his or her family, and the manufacturer all need to know what happened, which makes the investigation of the problem critical. To eliminate any improper investigation, manufacturers should have a trained crisis management committee in place before a complaint is received so that a standard operating procedures is followed defining what actions are to be taken and by whom.

Acknowledgment

The formal document that accepts a customer order; includes a delivery promise, method and time for payment, and identifies any exceptions to the terms and conditions stated on the customer's purchase order.

Chapter 11 Act

US permits legal protection from creditors under Chapter 11 of the US Federal Bankruptcy Act. Interesting, particularly when you study being on both side and what one can get away with legally. Time the law changes for the credible operation even though the change has been discussed for many decades.

Conflict of Interest

They range from personal to legal matters with the usual main conflict between the private interests and the official responsibilities of a person in a position of trust such as the company's top executive officers or a government official or agency.

Consumer Product Safety Act

CPSA is a significant consumer safety law. It is part of U.S. legislative law and augments the common law and case of product liability. Purpose of the law is: (1) to protect the public against unreasonable risks of injury associated with consumer products; (2) to assist consumers in evaluating the comparative safety of consumer products; (3) to develop uniform safety standards for consumer products and to minimize conflicting state and local regulations; and (4) to promote research and investigation into the causes and prevention of product-related deaths, illnesses, and injuries. Overall target is to prevent hazardous material and products or defective designed products from reaching the consumer.

Copyright

It is an intangible property such as the ownership of a design or literary property granted by law.

Defendant

While anyone along the trail of commerce (manufacturer, wholesaler, or retailer) can become a defendant in a law suit, it is usually the manufacturer who is held liable to the injured party. The manufacturer is the one with the "$ deepest pockets" or the one from which the largest award can be obtained.

Employee Assignment Invention

In assigning an invention, usually the employment contract will govern. However, some states have Employee Invention Laws. These laws, in effect, retain personal, nonbusiness related inventions for the employee as long as they are not made on the employer's equipment or time.

Expert Witness

Litigation in the plastic and other industries usually involves patent infringement, theft of trade secret, product liability, or a specific performance. With the usual patent law, the expert is expected to report on the obviousness of an invention. Prior art and knowledge of the requirements for patentability will often be key parts of the expert's

testimony. Unfortunately judges who have a weak technical background and little understanding of the patent law hear many of these cases. The job of the expert is to reduce a complex art or science into easy to understand testimony for all in the proceedings.

An expert witness is to be a person with substantial training in a specific field who can look at a set of data and come to a scientific conclusion about the merits of the issues. Target here is that any conflict between objectively and the highly opinionated atmosphere inherent in legal proceedings has always been problematic for technical people with ethics.

Insurance Risk Retention Act

With IRRA companies in the same industry are permitted to form a specialized insurance company to insure themselves. As an example, one was been established in Vermont 1992 that was called the Plastics Industry Risk Retention Group (PIRRG).

Invention

Chief requirement is that (1) it be an unobvious to a person having ordinary skill in the art to which the claim pertains and (2) knowing everything that has gone wrong before is not applicable.

Mold Contractional Obligation

Custom molders have traditionally assumed no responsibility for the legality of the design of the customer's product, the design of the molded product as a component of that product, or products produced to the customer's design and specification. In the event a molded product infringes, or is claimed to infringe, any letters of patents, or copyright, the customer has assumed the responsibility involved. Normally most quotation forms include clauses that explicitly detail the indemnification provisions and mold storage responsibility.

Patent

In USA a patent is awarded to the person first producing an invention, not necessarily who first applied for a patent. The opposite policy prevails in the rest of the world with USA policy probably changing in order to achieve worldwide patent law harmonization. USA utility patents (machines, equipment, etc.) in the past where good for at least 17 years after date the patent was issued. As of 1995, the patent is good for 20 years after the date the patent is filed (prior to the date it is issued) that eliminated those who would file for a patent and let it drag out for many years prior to being issued when it would be needed for infringement, etc.

Patentability

Qualifications for obtaining a patent on an invention or process (USA) are: (1) the invention must not have been published in any country or in public use in USA in either case for more than one year to date of filing application, (2) it must not have been known in USA before that date of invention by the applicant, (3) it must not be obvious to an expert in the art/technology, (4) it must be useful for a purpose not immoral and not injurious to the public welfare, and (5) it must fall within five statutory classes on which only patents may be granted, namely, (a) composition of material, (b) process of manufacture or treatment, (c) machine, (d) design, and (e) plant produces asexually.

Patent Information

Patents tend to be the literature of technology with full disclosure of its invention details. This legal document confers to its owner the right to exclude others from using it.

Patent Infringement

Generally, ignorance of the patent or trademark rights of others is no excuse to an

infringing activity. Moreover, it may give rise to costs and risks in withdrawal or recall of products, ads, attorney' fees, etc. These potential costs will probably outweigh the cost of the initial searches or clearances.

Patent Pooling with Competitor

In the past, USA competing companies could not cooperate, such as in R&D, without breaching antitrust laws. Patent pooling, such as collecting and cross-licensing patents, was precluded. Today the antitrust laws are reviewed, interpreted, and enforced less stringently, which permits industrial cooperation in selected and specific areas where poling does exist. This explanation is a simplistic summation to a very complicated situation.

Patent Search

There are three major steps to a patent search. (1) There is the US Patent Classification System that is a sort of subject index to all patents, (2) CASSIS is a computerized software information system provided by the USA patent office, and (3) review the patent that takes time; involves the weekly official worldwide gazettes, magazines, etc. There are many ways available to search the patent database in both US and worldwide, but one web that is particularly useful to the novice or occasional searcher is one offered by IBM locate at: http://www patents.IBM.com

Patent Term Extension

The PTE complex law of 1984 (USA) offers an opportunity to extend the effective life of patents for new medical inventions up to five years.

Patent Terminology

Preparing a patent and ensuring that proper and protective terms are used (to eliminate "substitutions") requires time and money to prepare a foolproof patent. Cost per patents has been in the millions of dollars.

Plaintiff

A lawsuit is a civil suit seeking compensation by the plaintiff for damages, usually money, for some type of liability against the responsible party(s). A product liability may arise as a result of a defect in design and/or manufacturer, improper service, breach of warranty, negligence in marketing, etc. Under the doctrine of strict liability the plaintiff must prove factual proof of damage. Before the trial the plaintiff is entitled to certain information by right of discovery. It includes all records that pertain to the alleged damage and depositions of individuals involved. Oral depositions before a court reporter permit both sides of the litigation to discover the important facts of the case.

Processor Collaborative Venture

PCV provides an innovative approach to cost containment (55). One method is to lower the cost of outsourcing parts and components by forming a group-purchasing venture. When legally structured meeting the established guidelines of the Antitrust Div. of the U.S. Dept. of Justice (DOJ), allow members to aggregate purchases in order to obtain competitive volume discounts, reducing their costs, and subsequently the prices charged to their customers. Such collaborations are often viewed by DOJ as not only benign, but procompetitive.

As explained by R. Branand (55) while U.S. manufacturers are well aware of the barriers imposed on U.S. collaborations by antitrust considerations. However they are usually not as familiar with the opportunities that are encouraged. Properly structured the competitor association can help USA companies achieve goals such as expanding into foreign markets, funding expensive innovations efforts, and lowering production and other

costs. For over a decade this powerful cost-cutter has been available to U.S. businesses, yet misapplied antitrust concerns have prevented many companies from pursuing its benefits.

Processor Contract

It is usually consider a subgroup to the custom processor. They have little involvement in the business of their customer. They usually just sell machine time.

Product Liability Law

Two types of law are involved; contract and tort. A contract is an agreement between two or more parties that is enforceable in a court of law. A tort is a civil wrong committed by the invasion of any personal or private right that each person enjoys by virtue of federal and state laws. The personal or private right affected must be one that is determined by law rather than by contract. In addition to the tortuous act, there must also be personal injury and/or property damage. Over half the USA states have adopted to varying degrees the doctrine of strict liability tort, that means that the injured person need only prove that a product was unreasonably dangerous to win the case. Various conditions make it easier to win cases. As an example proof that the manufacturer of the product is negligent is no longer required.

Protect Design

Five different methods of protecting your design exists in USA. Each is weighed according to its advantages and disadvantages based on specific needs. They are: (1) contracts/other party agrees not to make, use, etc. without designer's permission; (2) copyrights/protection exists upon creation of design; (3) trade dresses/protection when design is either inherently distinctive or has become distinctive; (4) utility patents/protects the functional and structural features of a product; and (5) design patents/protect the ornamental appearance of a product without regard to how it functions.

Protection Strategy

For a molder to control secrecy concerning proprietary information, the first approach is to keep it as a personal secret. If people have to be exposed to it, such as present or new employees, visitors, and customers since there exists a need to know, those people should sign a nondisclosure agreement. This agreement could set up problems since a person could already be familiar with the so-called secret.

Quotation

Document quote that states the selling price and other sales conditions of a material, product, etc. Did you know that by law if someone reports that verbally the vender made statements such as "buy this injection molding machine and all you have to do is push a button to make good/acceptable parts"... the vender is in trouble... even if that vendor wins the case (odds are against winning), it will be very expensive to be in court.

Right-to-Know

This law (Fed. Reg. 29 cfr 1910.1200) covers employees' right to know about the chemical hazards to which they are exposed if they exist in a working area.

Shop-Right

It is a term referring to a non-exclusive royalty-fee license given to a employer where an employee uses the employment's time and/or equipment to develop an invention. Shop-rights come into play when there is no assignment agreement.

Software and Patent

The Court of Appeals for the USA Federal Circuit issued (1992) a decision that could strengthen the legal position that so-called pure software could be patented (Arrhythmia Research Technology vs. Corazonix Corp. 22 USPQ2d 103 of CAFC march 12, 1992).

Tariff

It is basically a schedule of duties or cost rates imposed by a government on imported or in some countries exported goods. In certain areas of the world to offset tariff duties, worldwide free-trade agreements exist.

Term

It is important in the workplace and when legal actions occur that terms have their proper definition to ensure accuracy of discussions in the plant and/or in the court room.

Tort Liability

The tort laws have been impeding new biomaterial and medical device developments by the large companies. It is very difficult for them to justify the financial risk incurred from the relatively low level of their sales. Action is being taken to change the laws.

Trademark

TM is a symbol or insignia designating one or more proprietary products or the manufacture of such products, that has been officially registered and approved by the U.S. Patent and Trademark Office (PTO). The acceptable designation is a superior capital R enclosed in a circle, however, quotation marks may be used. There are three levels of TM protection namely: (1) common law covers unregistered TM with limited legal protection; (2) state registration where you register the TM and are protected in that state only, and (3) federal registration that offers registered TM protection across state lines.

Trade Name

TN is the name or style under which a concern does business. The government concerned alone or with a device such as a surrounding oval may register the TN.

Warranty

There are different items that have warranties such as equipment, products, and materials. Fulfillment of warranties tends to be a two-way situation. As an example when one buys equipment, you are not just buying equipment, you are entering into a relationship. This may sound tripe, but it is demonstrably true in the case of capital equipment. The warranty relationship can be defined in writing by the warranty document. It goes into detail as to what the OEM (original equipment manufacturer) seller promises to do in event of equipment failure due to specific causes. It also details the responsibilities of the equipment owner. Sometimes the expectations of the processor and OEM are seriously mismatched.

The best way to avoid this situation is to clarify understandings before the equipment is delivered. It is usually clear who pays for parts. Make sure you understand, however, the responsibilities vs. the OEM for shipping, travel, and other costs. The details can significantly defer from OEM to OEM.

Design Detractor and Constrain

As reviewed throughout this book, designing acceptable products requires knowledge of the behavior of the different plastics and their processing characteristics (Chapter 6, **MATERIAL VARIABLE** and Chapter 8 **EQUIPMENT/PROCESSING VARIABLE**).

Although there is no limit theoretically to the shapes that can be created, practical considerations must be met such as available

and size of processing equipment with cost. These relate not only to the product design, but also the mold or die design, since they must be considered as one entity in the total creation of a usable, economically feasible product.

Troubleshooting Design Problem/Failure

Troubleshooting is the art and science of remedying product defects after the process has demonstrated the ability to produce acceptable production products. Most defects respond to one of a variety of process and/or material changes. The target is knowing when a particular solution will work, and correctly identifying which problem is actually causing the defect. When making adjustments consider: (1) create a mental image of what should be happening, (2) look for obvious differences, (3) make only one change at a time designwise, materialwise, and/or processingwise, and (4) allow the process to stabilize after any change is made.

Studies have determined that probably 60% of defects result from the machine/equipment, 20% mold/die, 10% material, and 10% operator. Available are software programs already installed on the machines processor controller or available as a software package that can provide some troubleshooting help.

Troubleshooting Guide

With all types of equipment, materials, and products, troubleshooting guides are setup (usually required) to take fast, corrective action when products do not meet their performance requirements such as dimensions, shape, surface appearance, and physical and mechanical properties. This problem solving approach fits into the overall fabricating-design interface as summarized in the FALLO approach (Fig. 1-3). Troubleshooting guides are reviewed in throughout this book (1, 3, 6, 7, 20).

Many different guides are provided by equipment and material suppliers. However, the product "problems-to-solutions" are usually developed when setting-up a fabricating line by the processor. A simplified approach to troubleshooting is to develop a checklist that incorporates the rules of a problem-to-solving procedure. (1) Have a plan and keep updating it based on the experienced gained in operating the equipment. (2) Watch the processing conditions. (3) Change only one condition at a time. (4) Allow sufficient time for each change and keep some kind of a log of the action, with results, that are occurring. (5) Check housekeeping, storage areas, dryers, granulators, personnel clothing, and personnel behavior. (6) Narrow the range of areas in which the problem belongs, e.g. material storage and handling, mold/die, specific equipment in the fabrication line (such robot, cooling tank, and puller), specific control, product design, environment (humidity, ventilation location and direction of forced air, dust, etc.), people, and management.

The following provides an example as a guide pertaining to extruded products that starts with common operating problems and possible solutions. When possible start with feeding low bulk density plastic in a starved fed extruder. To avoid aeration and therefore increased potential for volumetric feed limitation, minimize the free fall path from the feeder to the extruder feed throat. If a barrel zone on the barrel constantly overrides or requires too much cooling to maintain a set point, it may be that the melting is being concentrated in that section. This can either exist because of screw design or an improper barrel heat profile. A simple and hopeful solution is to increase the melting prior to the "hot zone" of the screw (6).

Troubleshooting by Remote Control

To aid the manufacturing plants, remote troubleshooting has been available from different equipment manufacturers and service facilities. Users of certain microprocessor equipment need not be concerned about their plant's personnel's ability to service and maintain the equipment. Via a communication link from your computer controller to the

services central computer, a specialist and/or automatic device can immediately check out conditions in your controller as well as in the complete production line. This remote diagnostic link can also be used to set-up preventative maintenance programs.

Defining the Trouble

When setting up troubleshooting guides, as well as reviewing any problems or even open discussions on the subject of fabricating, it is important that the terms used to identify a problem be understandable, clear, and properly defined. As an example the word flaw could have different meanings to different people. Flaw could identify blush, burn, discoloration, fill-in, flow marks, glossiness, gouge, haze, inconsistency, misalignment, non-adhesion, nonuniform, pit, porosity, protrusion, runs, scratches, sink mark, smearing, speck, void, and weld line. This is "stretching" or "far-fetching" the term flaw but it should highlight the fact that a proper definition can eliminate problems.

Design Failure Theory

In many cases, a product fails when the material begins to yield "plastically." In a few cases, one may tolerate a small dimensional change and permit a static load that exceeds the yield strength. Actual fracture at the ultimate strength of the material would then constitute failure. The criterion for failure may be based on normal or shear stress in either case. Impact, creep and fatigue failures are the most common mode of failures. Other modes of failure include excessive elastic deflection or buckling. The actual failure mechanism may be quite complicated; each failure theory is only an attempt to explain the failure mechanism for a given class of materials. In each case a safety factor is employed to eliminate failure.

An example of a theory is the Griffith theory. It expresses the strength of a material in terms of crack length and fracture surface energy. Brittle fracture is based on the idea that the presence of cracks determines the brittle strength and crack propagation occurs. It results in fracture rate of decreased elastically stored energy that at least equals the rate of formation of the fracture surface energy due to the creation of new surfaces.

These failures could be due to the variability of the plastic material and/or fabrication control of equipment. Applying an approach such as the **Troubleshooting Guide** reviewed, can direct you to the solution.

Product Failure

Different techniques or methodologies are used to analyze premature molded product failures in order to meet cost requirements. Various methods of auditing and computer software programs are used or developed by designers and/or fabricators to provide an analysis of potential problems. Interesting is the fact that the actual time and cost to design products may take less than 5% of the total time and cost to fabricate products. Even though this is a relatively small percentage of the overall operation, it has a direct and important influence performancewise and costwise on the success or failure of fabricating molded products.

Avoiding product failures can depend, in part, on the ability to predict the performance of plastic materials and their shapes. With available time, the usual approach of product prototype and/or field-testing provides useful and reliable performance data when conducted properly. As an example designers continue to develop sophisticated computer methods for calculating stresses in complex structures.

The computational methods have replaced the oversimplified models of material behavior formerly relied on. However, for new and very complex product structures that are being designed to significantly reduce the volume of materials used and in turn the product cost, computer analysis is conducted on prototypes already fabricated and undergoing testing. This computer approach can result in early and comprehensive analysis of the effects of conditions such as temperature, loading rate, environment, and material

defects on nonstructural and/or structural reliability. The information is supported by stress-strain behavior collected in actual material evaluations.

When required, combined with the use of computers, the finite element analysis (FEA) method can greatly enhanced the capability of the structural analyst to calculate displacement and stress-strain values in complicated structures subjected to arbitrary loading conditions. In its fundamental form, the FEA technique is limited to static, linear elastic analysis. However, there are advanced FEA computer programs that can treat highly nonlinear dynamic problems efficiently.

Important features of these programs include their ability to handle sliding interfaces between contacting bodies and the ability to model elastic-plastic material properties. These program features have made possible the analysis of impact problems that in the past had to be handled with very approximate techniques. FEAs have made these analyses much more precise, providing better direction in locating high stress areas. Final verification of load-carrying capability usually requires actual testing of the fabricated product prototype based on computational analysis.

Managing Failure

Effective management of any product (IM, etc.) is much more than the production of immediate results. As Leonard A. Schlesinger (Harvard Business School) reviews, effective management includes creating the potential for achieving good results over the long run. There is the manager, who as president of a company, can produce spectacular results for a 3- to 10-year period. However that person can hardly be considered effective if, concurrently, people allow plant and equipment to deteriorate, creates an alienated or militant workforce, lets the company develop a bad name in the marketplace, and ignores new product development.

Dealing with current or impending problems is a key reality of people behavior in almost all-modern organizations. Coping with complexities associated with today and the immediate future absorbs the vast majority of time and energy for most managers.

Most managers will readily admit that their ability to predict their company's future is limited. Indeed, with the possible exceptions of death and taxes, the only thing entirely predictable is that things will change. Even for the most bureaucratic company in the most mature and stable environment, change is inevitable.

Over a period of 20 years, it is possible for a company, even one that is not growing, to experience numerous changes in its business, product markets, competition, government regulations, available technologies, business strategy, labor markets, and so on. These changes are the inevitable products of its interaction with a world that is not static.

Business and change Growing organizations tend to experience even more business-related changes over a long period of time. Studies will show that growing businesses not only increase the volume of the products or services they provide, but also tend to increase the complexity of their products or services, their forward or backward integration, their rate of product innovation, the geographic scope of their operations, the number and character of their distribution channels, and the number and diversity of their customer groups. While all of this growth-driven change is occurring, competitive and other external pressures also increase. The more rapid the growth, the more extensive the changes that are experienced.

These types of business changes generally require organizational adjustments. For example, if a company's labor markets change over time, it must alter its selection criteria and make other adjustments to fit the new type of employee. New competitors might emerge with new products, thus requiring renewed product development efforts and a new organizational design to support that effort. In a growing company, business changes tend to require major shifts periodically in all aspects of its organization.

The inability of an organization to anticipate the need for change and to adjust effectively to changes in its business or in its

organization causes problems. These problems sometimes take the form of poor collaboration and coordination; they may involve high turnover or low morale. Always, however, such problems affect the organization's performance goals that are not achieved and/or resources are wasted. Because change is inevitable and because it can so easily produce problems for companies, the key characteristic of an effective organization from a long-run viewpoint is its ability to anticipate needed organizational changes and to adapt as business conditions change.

Anticipatory skills can help prevent the resource drain caused by organizational problems, while adaptability helps an organization avoid the problems that change can produce. Over long periods of time, this ability to avoid an important and recurring resource drain can mark the difference between success and failure for an organization.

Bureaucratic dry rot It has been emphasized by a number of social scientists that in the past decades there has been expressed serious concern over what they call bureaucratic dry rot. We all pay a heavy price, they note, for the large, bureaucratic, nonadaptive organizations that are insensitive to employees' needs, ignore consumers' desires, and refuse to accept their social responsibilities.

Existing evidence suggests that although most contemporary organizations cannot be described as adaptive, many managers nevertheless appreciate the benefits of adaptability. When polled managers often respond that "ideally" they would like to have the ideal organization, but they also admit that their current organization does not have all or even some of these characteristics.

Business Failure

There is a formula for business failures based on Dun & Bradstreet, Inc. annually published data. The vast majority of the firms involved are small. Why do failures occur? D&B has offered the following tabular explanation (apparent cause/percent): inadequate sales/49.9, competitive weakness/25.3, heavy operating expenses/13.0, receivables difficulties/8.3, inventory difficulties/7.7, excessive fixed assets/3.2, poor location/2.7, neglect/0.8, disaster/0.8, fraud/0.5, and others/1.1. Numbers do not add up to 100% because some failures are attributed to a combination of apparent causes. One can include that product design directly influences competitive weakness and heavy operating expenses.